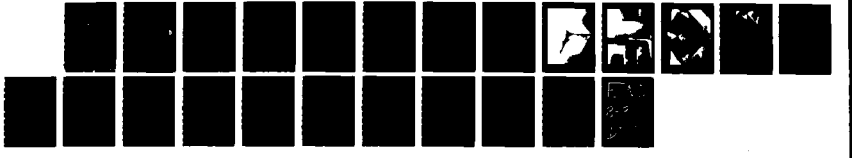
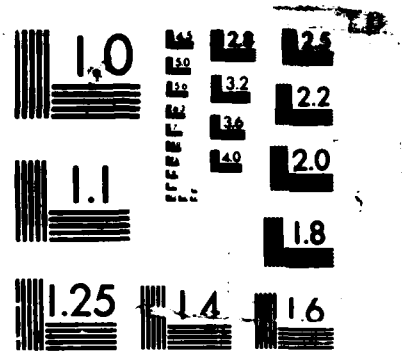
AD-A182 103 DEVELOPMENT OF MULTI-PURPOSE LOW FRAGILITY CONTAINER SYSTEM FOR SMALL LIG (U) AIR FORCE PACKAGING EVALUATION AGENCY WRIGHT-PATTERSON AFB OH L A WOOD

UNCLASSIFIED JUN 87 DSTZT-87-R-02 F/G 15/5 NL





MICROCOPY RESOLUTION TEST CHART

(12)

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DSTZT Report NO: -87-R-02
AFPEA PROJECT NO: 85-P-146

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DEVELOPMENT OF MULTI-PURPOSE LOW FRAGILITY CONTAINER SYSTEM FOR SMALL, LIGHTWEIGHT ITEMS

HQ AFLC/DSTZT
Air Force Packaging Evaluation Agency
Wright-Patterson AFB, Ohio 45433

JUNE 1987

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AFPEA PROJECT NO: 85-P-146

TITLE: Development of Specialized Protective Pack for Small, Lightweight Items

ABSTRACT

The objective of this project was to develop a multi-purpose pack to provide a protection level of at least 15Gs for small, shock sensitive, lightweight items (such as gyros and electronic components) within the weight range of 1 to 5 pounds. The scope of this effort was later expanded to include items up to 10 pounds using a second pack design.

Two packs were developed that satisfy all requirements. The first pack provided 15G protection for items in the 1 to 4 pound weight range; the second pack provided 15G protection for items in the 4 to 10 pound weight range, thus covering a total weight range of 1 to 10 pounds.

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INTRODUCTION

In January 1986 this agency initiated a project to develop a multi-purpose, low fragility container system for small, lightweight items. Former attempts to develop a system of this type have failed. The success of this effort is believed to be due to two factors. The first was a carefully constructed analytical model, calculated to reduce the number of variables introduced. This was achieved by using a cubical pack, with the resulting symmetry greatly simplifying calculations.

The second reason for success was the innovation of using smooth surfaced cushion covers. The result of this was a reduction in friction, thus allowing the system response to approach theoretical values. → to 1473 p. 17

Analytical models were developed and tested using AFPEA's Package Cushion design computer program. The results of this analysis predicted that with the use of reduced area techniques current technology was suitable, and the use of MIL-P-26514, Type 1, Class 2, Grade A, polyurethane cushioning material would satisfy all requirements.

Most cushioning materials were found to be too stiff to provide adequate dynamic displacement for a lightweight item. The only other alternative, rubberized hair, exhibits both cost and performance drawbacks, making it unsuitable in this application. The material can only be purchased in the required thickness by special order, which is not cost effective, and the performance is degraded over time and repeated use with the material losing its ability to absorb energy as well as developing a compression set.

The computer prediction was confirmed by subsequent testing, the results of which are provided in Appendices I and II.

DESCRIPTION OF THE TEST PACKS

Both containers were fabricated from single wall fiberboard in accordance with PPP-B-636, Style FTC (see figure 1). These containers included a cushioning system consisting of six 8 x 8 x 6 inch polyurethane foam (MIL-P-26514, Type 1, Grade A) cushions. The inner containers are also single wall fiberboard. Size data is listed in Table 1.

TABLE 1 - CONTAINER DATA

Con-tainer	Inner Ctnr OD(In)	Exterior Ctnr ID(In)	Weight Range (Lbs)	Maximum Item Size(In)	Inner Ctnr Net Wt(Lbs)	Total Pack Tare Wt(Lbs)
1	8X8X8	20 1/2X 20 1/2X20 1/2	1-4	7 1/2X 7X6 1/4	5.6	17
2	10X10X10	22 1/2X 22 1/2X22 1/2	4-10	9X 9X9 1/2	3.5	14

In both containers the cushions were covered with MIL-B-131 material with the smooth side out, to reduce friction between the primary container and the cushioning material (see figure 2).

The simulated load was restrained in the inner container by wrapping it in several layers of PPP-C-1752 (1/4 inch thick) polyethylene foam. This material was chosen because it is a common dunnage material, available at the Air Force's Air Logistics Centers (ALCs) and most bases.

INSTRUMENTATION AND EQUIPMENT

The following instrumentation and equipment was employed for this evaluation:

Oscilloscope, Tektronic, 4 channel storage, Model 565B

Accelerometer, tri-axial, Endevco, Model 2233E

Amplifiers (3 ea), Endevco, Model 2424C

Power Supply, Endevco, Model 2622C

Drop Tester, Gaynes, Model 125

TEST PROCEDURES AND RESULTS

The free fall drop tests were conducted in accordance with Federal Test Method Standard 101C, Method 5007, Procedure A, Level B, 27 inch drop height. The test loads consisted of 1 pound, 4 pound, and 10 pound plywood and aluminum models to

simulate actual items. A tri-axial accelerometer was secured at the center of gravity of each test load. The drop test results are summarized in Table II. Complete test data is provided in Appendices I and II.

TABLE II - DROP TEST DATA

Average Peak Acceleration - Gs (Resultants)			
	Sides	Edges	Corners
Container 1			
1 Lb Load	10.2	9.6	9.9
4 Lb Load	13.3	7.6	8.8
Container 2			
4 Lb Load	10.5	12.0	12.7
10 Lb Load	12.3	8.0	6.2

DISCUSSION

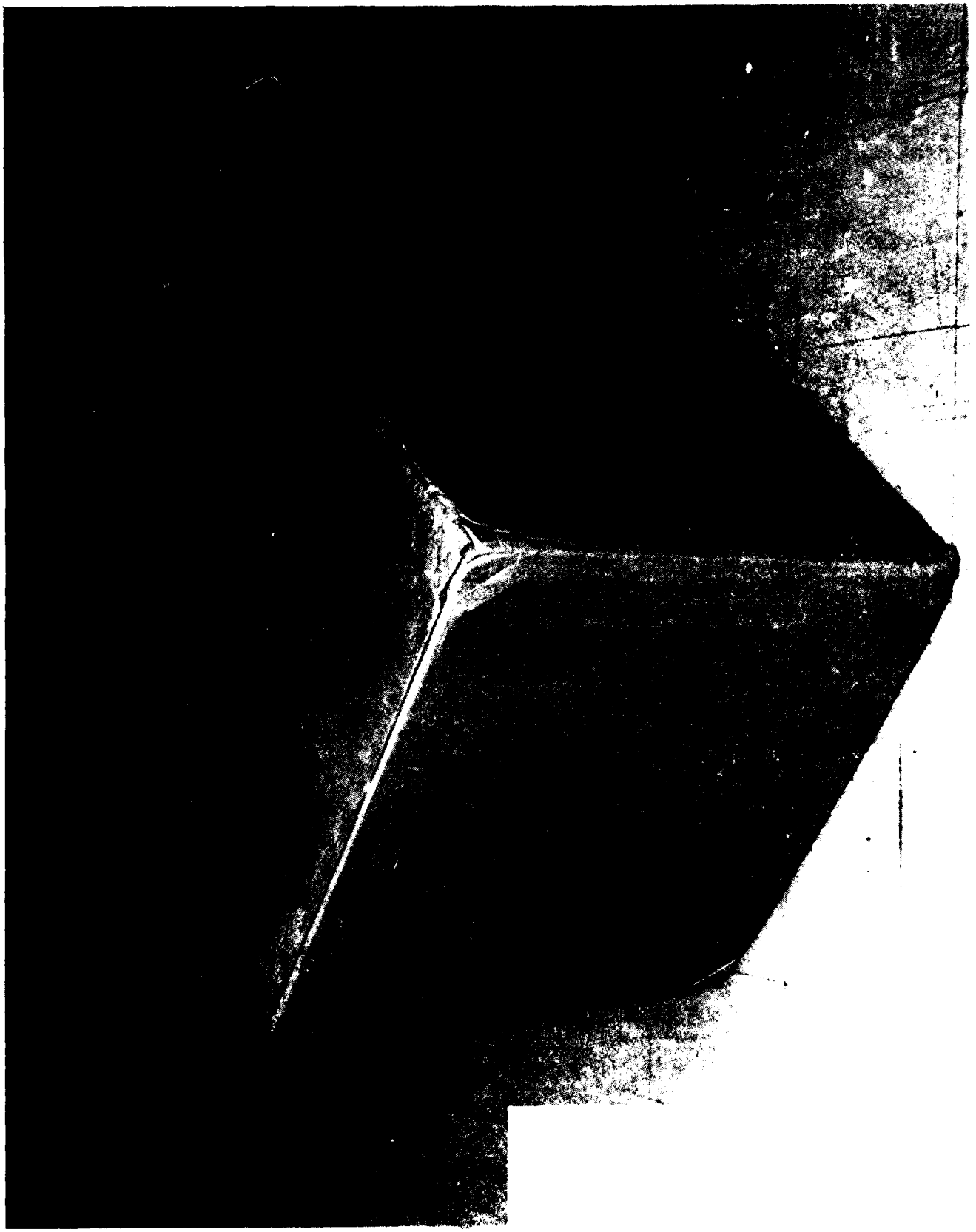
During testing, it was noted that when the pack of maximum weight was impacted on corners and edges, the inner container exhibited a tendency to rotate in the cavity. However, as soon as the container was rolled over to an opposite side or edge, the system would return to equilibrium. In no case did the load jam into a corner and impact the exterior container or "bottom out." This is attributed to the smooth surface of the MIL-B-131 cushion covers (see figure 2). When the packs were tested without the cushion covers, the peak G levels were dramatically greater.

In both pack designs it was necessary to add ballast to the inner container to achieve 15G protection over the required weight range. In pack number 1 this was accomplished by the addition of two 7 1/2X7 1/2X3/8 aluminum plates and a fiberboard liner to prevent movement (see figure 3). In pack number 2 the ballast consists of four 9 1/2X9 1/2X1/4 plywood plates adhesively bonded to the inside of the inner container (see figure 4). These methods were selected because of their simplicity and cost effectiveness.

The simulated load was restrained in the inner container by wrapping it with sheets of 1/4 inch thick PPP-C-1752 polyethylene foam. Similar results were achieved using bubble wrap, (PPP-B-795), and polyurethane Foam-In-Place (MIL-P-26514, Type II). Poor results were obtained when prefoamed polyurethane (MIL-P-26514, Type I) was used. This is attributed to a phase shift in the shock pulse that occurs when the cushioning materials in the interior and exterior are of the same type. Since MIL-P-26514, Type I is not commonly used as dunnage, this is not anticipated to be a problem.

CONCLUSION

The two pack designs developed in this study and depicted in appendices III and IV will provide 15G shock protection for a wide variety of items. Both packs are extremely low cost and can be fabricated by any ALC from standard packaging materials. The availability of these containers will provide the logistics system with a cost effective alternative to custom designed shipping containers for each light weight item.



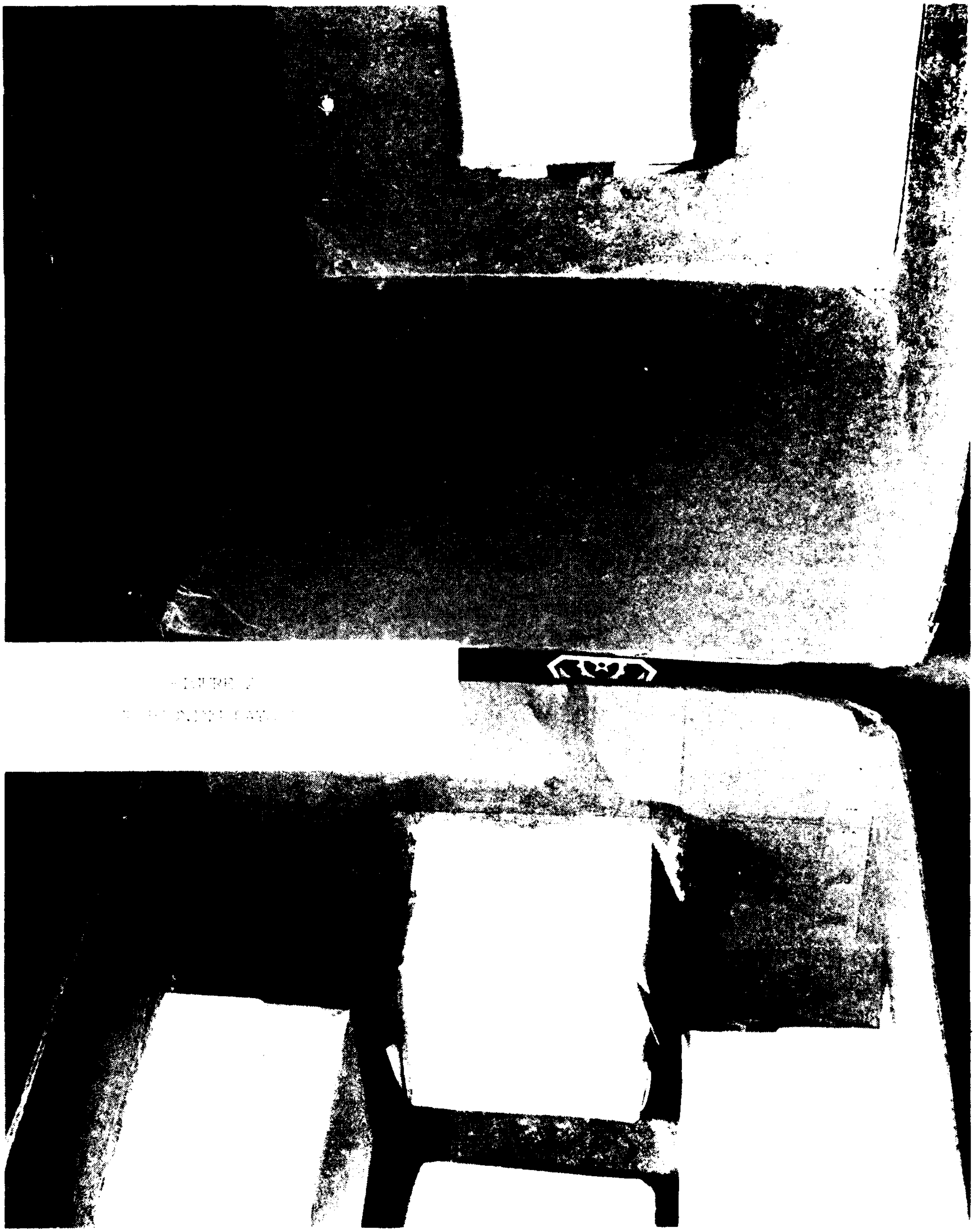
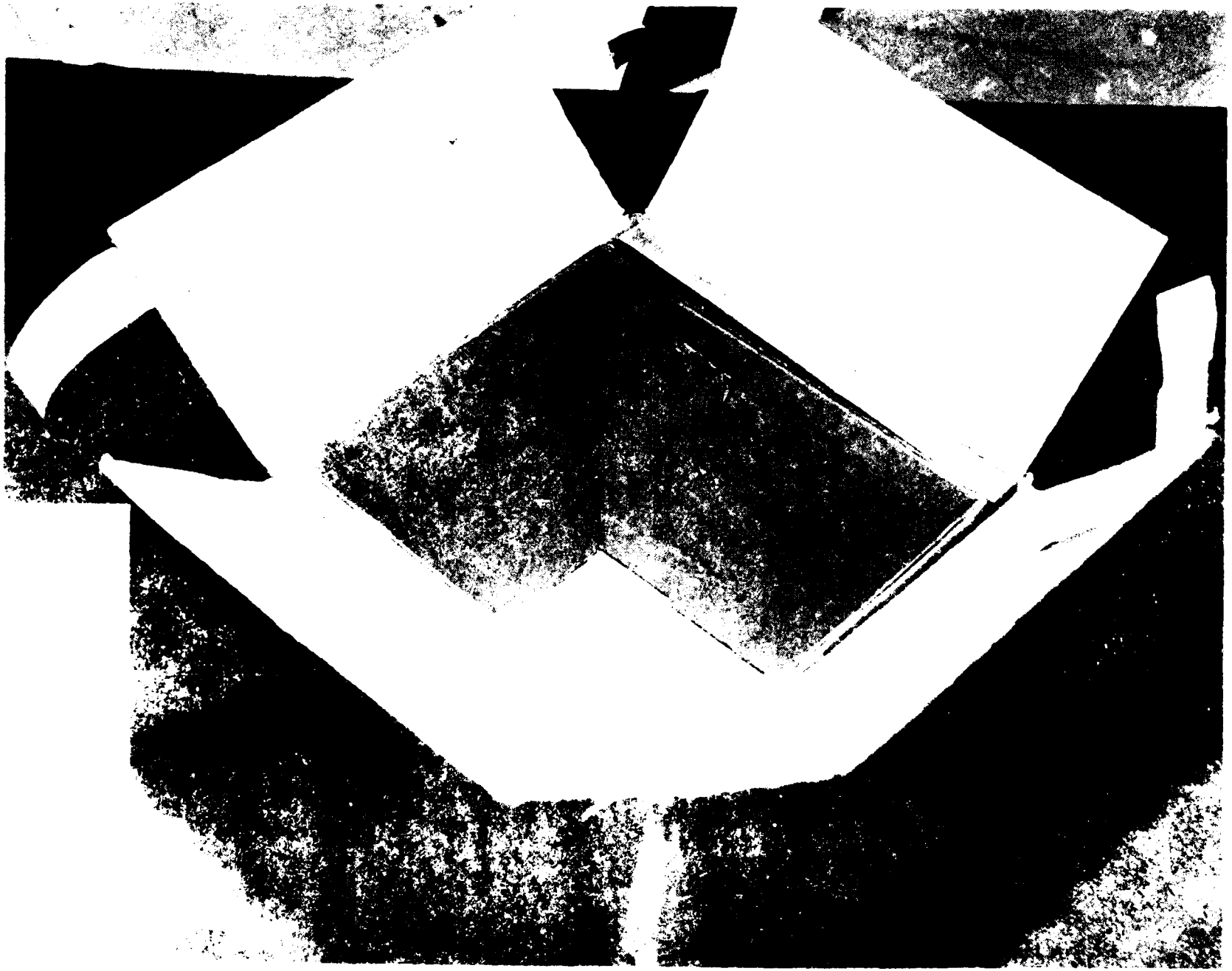


FIGURE 2
[illegible]



PROCEDURE: A DATE: 10 Nov 86
DROP HEIGHT: 27"
PACK PROTOTYPE: 8 x 8 x 8 PRI
22 x 22 x 22 FTC
8 x 8 x 6 Grade A Cushions
DUMMY LOAD: Gyro & PRI Ctnr
WEIGHT: .98 + 5.82 = 6.8

PROCEDURE: A DATE: 10 Nov 86
DROP HEIGHT: 27"
PACK PROTOTYPE: 8 x 8 x 8 PRI
22 x 22 x 22 FTC
8 x 8 x 6 Grade A Cushions
DUMMY LOAD: Gyro & PRI Ctnr
WEIGHT: 4.1 + 5.6 = 9.7

ORIENTATION (FLAT (a), EDGE (a, b), CORNER (a, b, c))

TEST 1 SS = .106

	a	b	c	X	Y	Z	R	
	3			11	2	0	11.2	Side Avg 10.2
	1			11	1	6	12.6	
	2			4	3	10	11.2	
	4			2	2	8	8.5	
	5			1	8	2	8.3	
	6			4	8	2	9.1	
	1	2		3	2	8	8.8	Edge Avg 9.6
	3	4		5	2	9	10.5	
	1	4		8	1	5	9.5	
	2	3		9	2	7	11.6	
	3	5		6	9	1	10.9	
	1	6		4	5	3	7.1	
	1	5		5	5	1	7.1	
	3	6		8	5	1	9.5	
	2	5		1	9	5	10.3	
	4	6		1	7	7	9.9	
	4	5		2	5	8	9.6	
	2	6		4	4	8	9.8	
	1	4	5	7	3	7	10.3	Corner Avg 9.0
	2	3	6	9	5	4	11.0	
	1	2	6	1	6	7	9.3	
	3	4	5	4	5	9	11.0	
	1	4	6	6	6	4	9.4	
	2	3	5	7	8	4	11.4	
	3	4	6	5	6	5	9.3	
	1	2	5	2	5	5	7.3	

TEST 2 SS = .152

	a	b	c	X	Y	Z	R	
1	3			4	13	1	13.6	Side Avg 13.3
2	1			1	15	1	15.1	
3	2			1	1	15	15.1	
4	4			1	1	12	12.1	
5	5			11	1	3	11.4	
6	6			12	2	2	12.3	
7	1	2		1	4	5	6.5	Edge Avg 7.6
8	3	4		1	6	6	8.5	
9	1	4		1	4	6	7.3	
10	2	3		1	6	6	8.5	
11	3	5		5	6	3	8.4	
12	1	6		6	4	1	7.3	
13	1	5		8	2	1	8.3	
14	3	6		6	5	1	7.9	
15	2	5		5	2	5	7.7	
16	4	6		6	1	5	7.9	
17	4	5		5	1	4	6.5	
18	2	6		5	1	4	6.5	
19	1	4	5	8	2	7	10.8	Corner Avg 8.8
20	2	3	6	8	8	4	12.0	
21	1	2	6	7	3	6	9.7	
22	3	4	5	5	6	2	6.5	
23	1	4	6	5	2	5	7.4	
24	2	3	5	5	5	3	7.7	
25	3	4	6	6	5	4	8.8	
26	1	2	5	4	2	6	7.5	

PROJECT NUMBER: 85-P-146 TESTED BY: LA Wood
SPECIFICATION: CW-78
COMMENTS: Same pack tested for 1 Lb and 4.1 Lb load
PRI ctnr contains 4.2 Lbs aluminum ballast
Cushions have MIL-B-131 covers
NOTE: Actual Wt range = 6.8 # to 9.7 #

CTMS 101C: METHOD 5007

DROP TEST (FREE FALL) WORKSHEET

PROCEDURE: A DATE: 10 Nov 86
DROP HEIGHT: 27"
PACK PROTOTYPE: 10 x 10 x 10 PRI
23 x 23 x 23 FTC
8 x 8 x 6 Grade A Cushions
DUMMY LOAD: Gyro + PRI Ctnr
WEIGHT: 4.1 + 3.5 = 7.6 Lbs

PROCEDURE: A DATE: 10 Nov 86
DROP HEIGHT: 27"
PACK PROTOTYPE: 10 x 10 x 10 PRI
23 x 23 x 23 FTC
8 x 8 x 6 Grade A Cushions
DUMMY LOAD: Gyro + PRI Ctnr
WEIGHT: 10.1 + 3.5 = 13.6 Lbs

IDENTIFICATION (FLAT (a), EDGE (a, b), CORNER (a, b, c))

TEST 1 SS = .119

	a	b	c	X	Y	Z	R	
	3			1	11	3	11.4	Side Avg 10.5
	1			3	12	0	12.4	
	2			8	5	2	9.6	
	4			9	1	4	9.9	
	5			3	2	8	8.8	
	6			1	4	10	10.8	
	1	2		10	9	0	13.4	Edge Avg 12.0
	3	4		8	8	3	11.7	
	1	4		6	10	1	11.7	
	2	3		9	8	0	12.0	
	3	5		3	9	8	12.4	
	1	6		5	9	8	13.0	
	1	5		1	11	7	13.1	
	3	6		2	6	9	12.2	
	2	5		9	2	6	11.0	
	4	6		8	2	9	12.2	
	4	5		5	4	8	10.2	
	2	6		7	4	8	11.3	
	1	4	5	8	8	7	13.3	Corner Avg 12.7
	2	3	6	8	7	9	13.9	
	1	2	6	7	9	6	12.9	
	3	4	5	5	7	7	11.1	
	1	4	6	4	8	8	12.0	
	2	3	5	8	6	7	12.2	
	3	4	6	5	8	7	11.7	
	1	2	5	9	9	7	14.3	

TEST 2 SS = .21

	a	b	c	X	Y	Z	R	
1	3			2	14	2	14.3	Side Avg 12.3
2	1			1	11	1	11.1	
3	2			12	3	1	12.4	
4	4			11	2	1	11.2	
5	5			4	1	10	10.8	
6	6			1	2	14	14.2	
7	1	2		7	4	1	8.1	Edge Avg 8.0
8	3	4		5	5	1	7.1	
9	1	4		5	5	1	7.1	
10	2	3		5	6	2	8.1	
11	3	5		2	5	4	6.7	
12	1	6		2	6	5	8.1	
13	1	5		3	5	6	8.4	
14	3	6		2	5	6	8.1	
15	2	5		6	3	4	7.8	
16	4	6		4	1	5	6.5	
17	4	5		7	1	8	10.7	
18	2	6		6	4	5	8.8	
19	1	4	5	3	1	5	5.9	Corner Avg 6.2
20	2	3	6	4	2	5	6.7	
21	1	2	6	5	2	5	7.3	
22	3	4	5	5	3	4	7.1	
23	1	4	6	4	2	4	6.0	
24	2	3	5	4	3	2	5.4	
25	3	4	6	4	2	3	5.4	
26	1	2	5	2	5	1	5.5	

TEST [illegible]: 85-P-146 TESTED BY: LA Wood
[illegible]: CW-78
[illegible]: Same pack tested for 4 Lb and 10.1 Lb load
PRI ctnr contains 2 Lb plywood ballast
Cushions have MIL-B-131 covers
NOTE: Actual Wt range = 7.6 # to 13.6 #

SPECIAL PACKAGING INSTRUCTION

CODE ID	SPI NO. (TPO)
97151	TBD2
	SHEET 1 OF 3

PART OR DRAWING NO.	NATIONAL STOCK NO.	CURRENT REV
.	.	.

ILL. .

ITEM NOMENCLATURE
CONTAINER, SHIPPING, 15G, 1-4 LB NET.

ORIGINAL DATE
8 JAN 87

CHK. .
ENGR. L. A. WOOD
AUTH. .

PRESERVATION IAW MIL-P-116

LEVEL A METHOD	.
LEVEL B METHOD	.
LEVEL C METHOD	.
QUP	001
ICQ	.
CLEANING	.
DRYING	.
PRESERVATIVE	.

MARKING IAW MIL-STD-129

SPECIAL MARKINGS:
A) SPI NO. .
B) REUSABLE CONTAINER AND DUNNAGE
DO NOT DESTROY

PACKING AS SPECIFIED BELOW AND BILL OF MATERIALS

LEVEL	SPEC	STYLE	TYPE	CL	VRTY	GR
A	PPP-B-636	FTC	CF	WR	SW	V3C
B	PPP-B-636	FTC	CF	WR	SW	V3C
C	PPP-B-636	FTC	CF	WR	SW	V3C

	LEVEL A	LEVEL B	LEVEL C
GROSS CU FT	5.4	5.4	5.4
GROSS WT LBS	VARIES	.	.
DESIGN FRAGILITY G	15	15	15

	LENGTH	WIDTH	DEPTH
CNTR I.D.	20 1/2	20 1/2	20 1/2
CNTR O.D.	21	21	21
ITEM DIM	7 1/2	7	6 1/4
ITEM WT LBS	1 TO 4 LBS		

REVISIONS

LTR	DESCRIPTION	DATE	APPVD
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.	.	.	.
.	.	.	.
.	.	.	.
.	.	.	.

CLOSURE IAW PPP-B-636

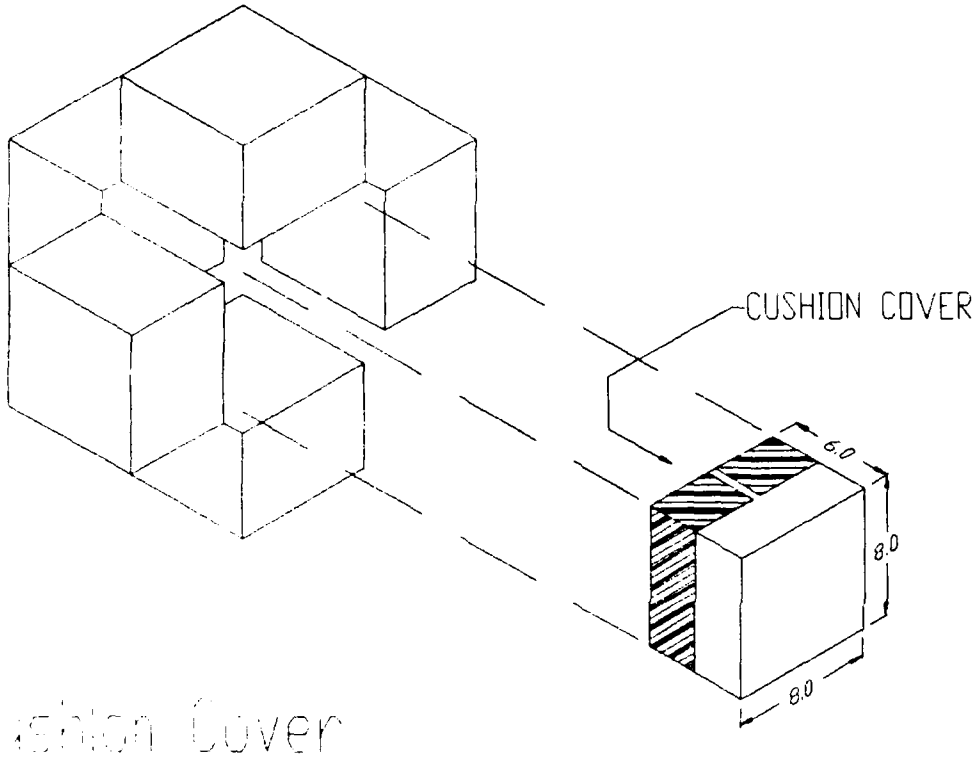
P/N	QTY PEQD	NOMENCLATURE OR DESCRIPTION	SIZE (INCHES UNLESS OTHERWISE NOTED)	MATERIAL SPECIFICATION
6	6	CUSHION COVER	14 X 14	MIL-B-131 CLASS 1
5	6	CUSHION	8 X 8 X 6	MIL-P-[illegible] TYPE I CLASS [illegible] GRADE A
4	1	LINER	7 1/2 x 6 3/4 x 7 1/2	PPP-F-320
3	2	ALUMINUM PLATE	3/8 X 7 1/2 x 7 1/2	ALUMINUM
2	1	INTERIOR CONTAINER (ID)	7 1/2 x 7 1/2 x 7 1/2	PPP-B-[illegible] STY-FTC TYPE [illegible] CLOSURE SW
1	1	EXTERIOR CONTAINER (ID)	20 1/2 X 20 1/2 X 20 1/2	REF [illegible] REF SHEET 1 "REMARKS"

DD FORM 2169 MOD

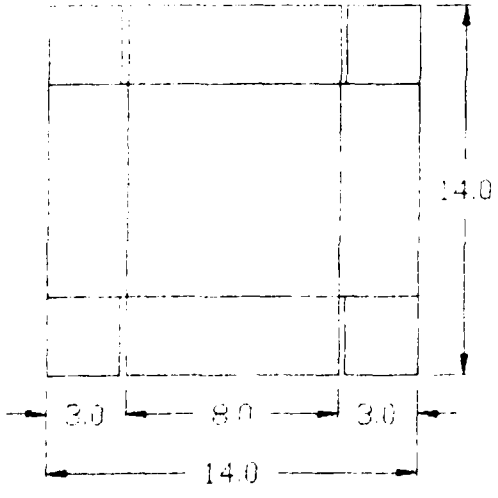
COMPUTER GENERATED

SPECIAL PACKAGING INSTRUCTION	CODE ID 97151	SPI NO. (TPO) TBD2
ITEM NOMENCLATURE CONTAINER, SHIPPING, 15G, 1-4 LB.NET.		SHEET 2 OF 3

Cushioning Detail

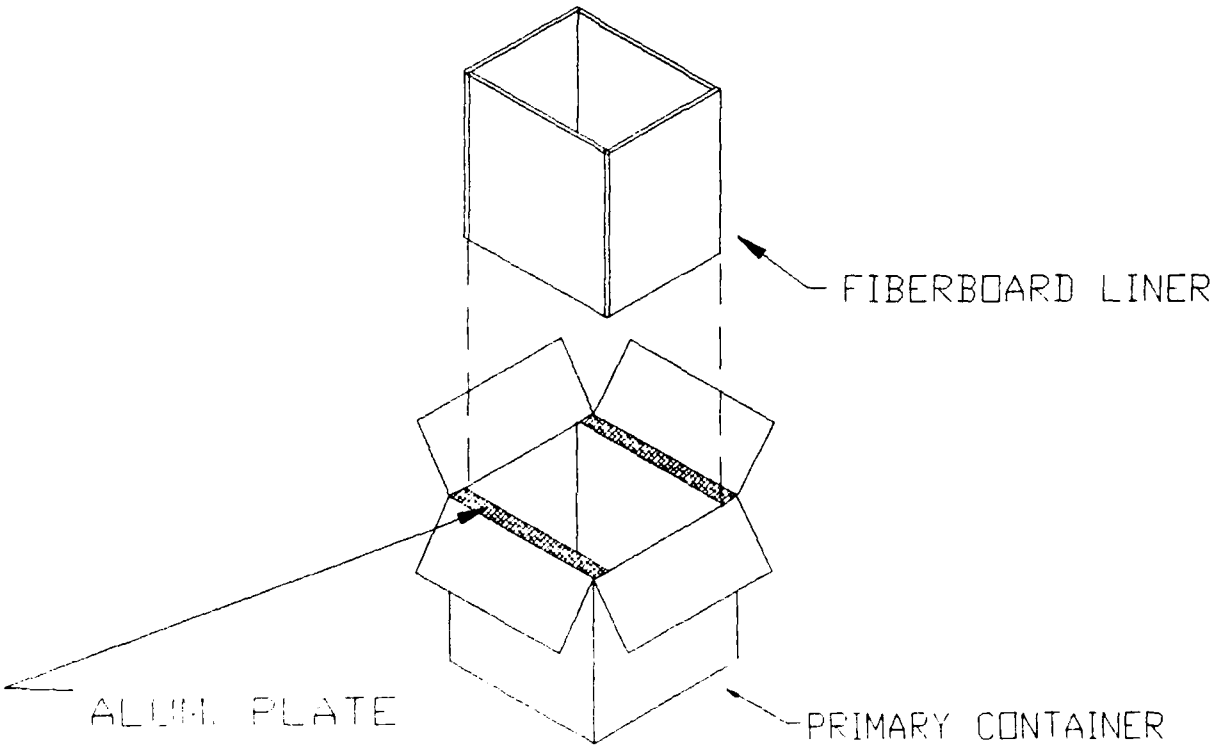


Cushion Cover Flat Pattern

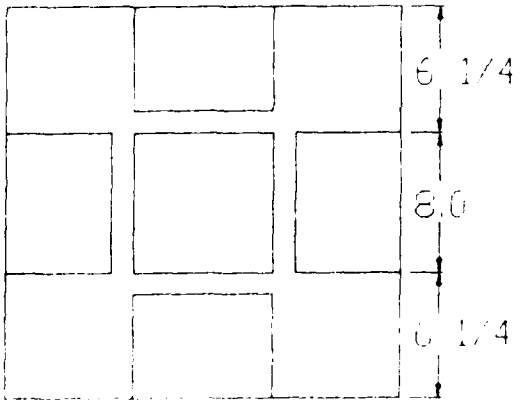


SPECIAL PACKAGING INSTRUCTION	CODE ID 97151	SPI NO. (TPO) TBD2
ITEM NOMENCLATURE CONTAINER, SHIPPING, 15G 1-4 LB.NET.		SHEET 3 OF 3

Primary Container Detail



Container Layout



SPECIAL PACKAGING INSTRUCTION

CODE ID	SPI NO. (TPO)
97151	TBD1
	SHEET 1 OF 3

PART OR DRAWING NO.	NATIONAL STOCK NO.	CURRENT REV	ILL.
.	.	.	.

ITEM NOMENCLATURE	ORIGINAL DATE	CHK. .
CONTAINER, SHIPPING, 15G, 4-10 LB NET	8 JAN 87	ENGR. L. A. WOOD AUTH. .

PRESERVATION IAW MIL-P-116

LEVEL A METHOD	.
LEVEL B METHOD	.
LEVEL C METHOD	.
QUP	001
ICQ	.
CLEANING	.
DRYING	.
PRESERVATIVE	.

MARKING IAW MIL-STD-129

SPECIAL MARKINGS:

A) SPI NO.

B) REUSABLE CONTAINER AND DUNNAGE
DO NOT DESTROY

PACKING AS SPECIFIED BELOW AND BILL OF MATERIALS

LEVEL	SPEC	STYLE	TYPE	CL	VRTY	GR
A	PPP-B-636	FTC	CF	WR	SW	V3C
B	PPP-B-636	FTC	CF	WR	SW	V3C
C	PPP-B-636	FTC	CF	WR	SW	V3C

	LEVEL A	LEVEL B	LEVEL C
GROSS CU FT	7.0	7.0	7.0
GROSS WT LBS	VARIES	.	.
DESIGN FRAGILITY G	15	.	.

	LENGTH	WIDTH	DEPTH
CNTR I.D.	22 1/2	22 1/2	22 1/2
CNTR O.D	23	23	23
ITEM DIM	9 1/2	9	9
ITEM WT LBS	4 TO 10 LBS		

REVISIONS			
LTR	DESCRIPTION	DATE	APRVD
.	.	.	.
.	.	.	.
.	.	.	.
.	.	.	.
.	.	.	.
.	.	.	.

CLOSURE IAW PPP-B-636

5	1	CUSHION	MIL-P-26514, TYPE II, GRADE A
4	2	PLYWOOD END	ANSI-HPVA
3	2	PLYWOOD SIDE	ANSI-HPVA
2	1	INTERIOR CONTAINER	PPP-B-636, STYLE FTC, TYPE CF, CL-DOM, SW
1	1	EXTERIOR CONTAINER	PPP-B-636, SEE SHEET 1 "PACKING"

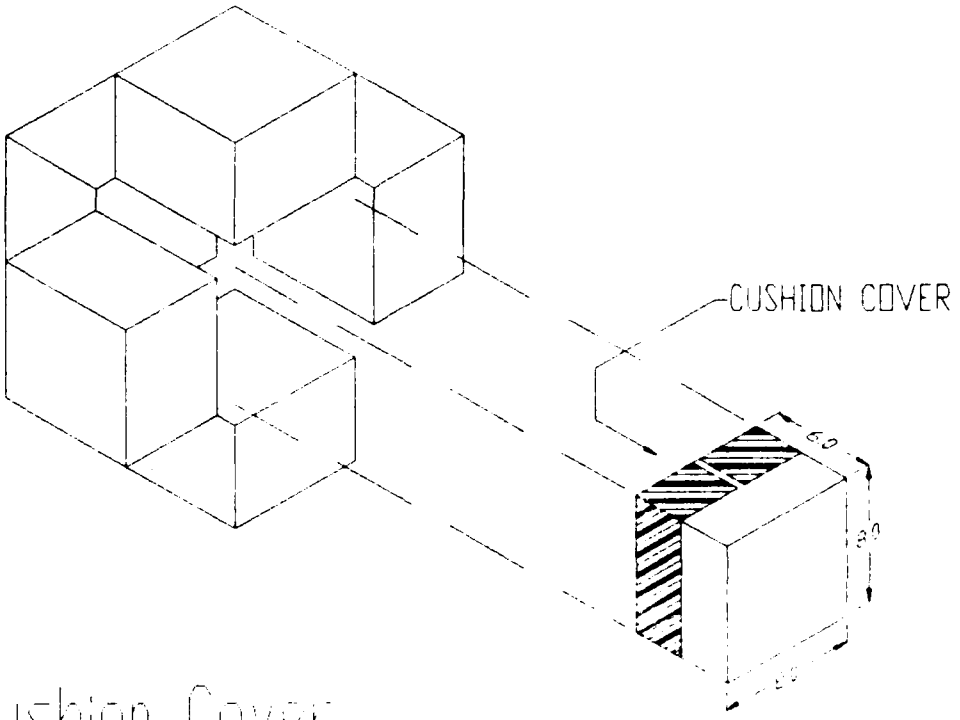
ITEM NO.	QTY	NOMENCLATURE OR DESCRIPTION	DIMENSIONS (UNLESS SPECIFIED)	MATERIAL SPECIFICATION

DN 183

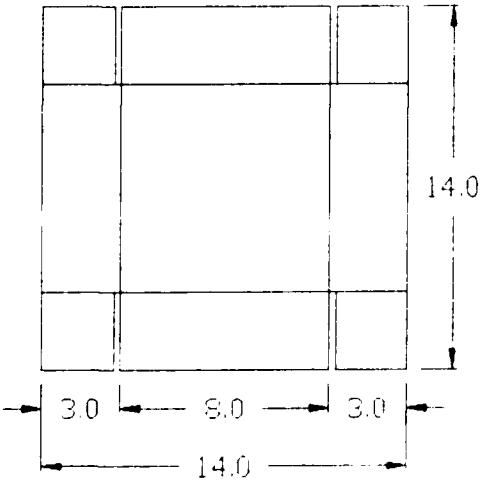
COMPUTER GENERATED

SPECIAL PACKAGING INSTRUCTION	CODE ID 97151	SPI NO. (TPO) TBD1
ITEM NOMENCLATURE CONTAINER, SHIPPING, 15G, 4-10 LB.NET		SHEET 2 OF 3

Cushioning Detail

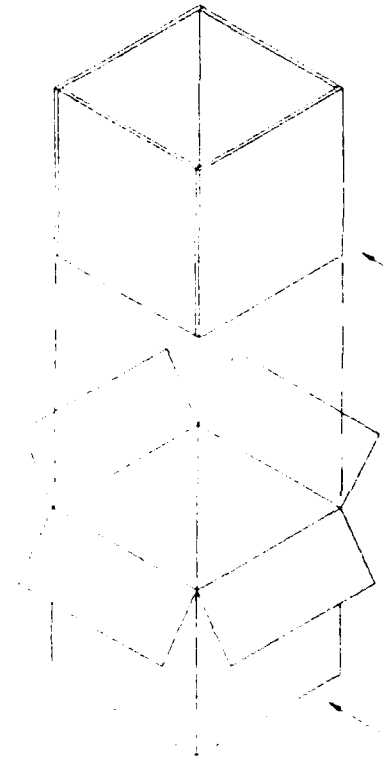


Cushion Cover Flat Pattern



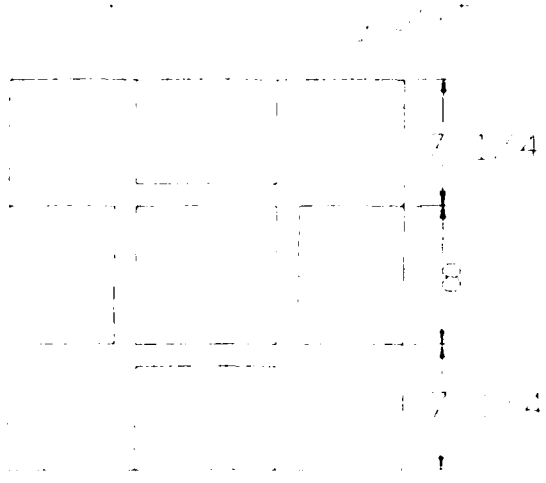
SPECIAL PACKAGING INSTRUCTION	CODE ID 97151	SPI NO. (TPO) TBD1
ITEM NOMENCLATURE CONTAINER, SHIPPING, 15G, 4-10 LB.NET		SHEET 3 OF 3

Primary Container Detail



1/4 INCH PLYWOOD
FRAME, SIDES ONLY

PRIMARY CONTAINER



AD-A182103

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REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b. RESTRICTIVE MARKINGS UNLIMITED DISTRIBUTION
2a. SECURITY CLASSIFICATION AUTHORITY N/A	3. DISTRIBUTION/AVAILABILITY OF REPORT APPROVED FOR PUBLIC RELEASE DISTRIBUTION UNLIMITED
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) DSTZT Report No. 87-R-02	5. MONITORING ORGANIZATION REPORT NUMBER(S) DSTZT Report No: 87-R-02
6a. NAME OF PERFORMING ORGANIZATION Air Force Packaging Evaluation Agency 6b. OFFICE SYMBOL (If applicable) HQ AFLC/DSTZT	7a. NAME OF MONITORING ORGANIZATION Air Force Packaging Evaluation Agency
6c. ADDRESS (City, State and ZIP Code) HQ AFLC/DSTZT Wright-Patterson AFB OH 4533-5999	7b. ADDRESS (City, State and ZIP Code) HQ AFLC/DSTZT Wright-Patterson AFB OH 45433-5999
8a. NAME OF FUNDING/SPONSORING ORGANIZATION Air Force Packaging Evaluation Agency 8b. OFFICE SYMBOL (If applicable) HQ AFLC/DSTZT	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER N/A
8c. ADDRESS (City, State and ZIP Code) HQ AFLC/DSTZT Wright-Patterson AFB OH 45433-5999	10 SOURCE OF FUNDING NOS PROGRAM ELEMENT NO. / PROJECT NO. 85-P-146 / TASK NO. / WORK UNIT NO
11. TITLE (Include Security Classification) Development of Multi-purpose Low Fragility ~~Container System for Small, Lightweight Items~~	85-P-146
12. PERSONAL AUTHOR(S) WOOD, LARRY A.	
13a. TYPE OF REPORT FINAL 13b. TIME COVERED FROM Apr 85 TO Dec 86	14. DATE OF REPORT (Yr., Mo., Day) December 1986 15. PAGE COUNT
16. SUPPLEMENTARY NOTATION	
17. COSATI CODES FIELD / GROUP / SUB GR	18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number) Packaging, Low Fragility, Multi-purpose

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

The objective of this project was to develop a multi-purpose pack to provide a protection level of at least 15Gs for small, shock sensitive, lightweight items (such as gyros and electronic components) within the weight range of 1 to 5 pounds. The scope of this effort was later expanded to include items up to 10 pounds using a second pack design.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT ☐ DTIC USERS ☐	21 ABSTRACT SECURITY CLASSIFICATION
22a. NAME OF RESPONSIBLE INDIVIDUAL LARRY A. WOOD	22b TELEPHONE NUMBER (Include Area Code) (513) 257-4519 22c OFFICE SYMBOL HQ AFLC/DSTZT

DD FORM 1473, 83 APR EDITION OF 1 JAN 73 IS OBSOLETE

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